THE FOREST BESIDE ME: THE USE OF EDUCATIONAL SOFTWARE, AS A TOOL OF TEACHING AND LEARNING ENVIRONMENTAL ISSUES.

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Abstract

This paper presents the findings of a software application, in secondary schools that was developed to inform and sensitize students in large scale environmental issues, such as climate change and its effect upon forest ecosystem. The use of this software demonstrates, among others, the relationship between the environment and education in a theoretical and empirical context and students' active involvement in the teaching and learning process. Additionally, we have addressed the model's contribution, whether effective or not, in achieving the goals of the environmental education in schools, as set out in the curricula, i.e. "Principles of Environmental Science", "Natural Resources' Management". The ecological theory behind the software is based on the theory of forest gaps dynamics. After the application of this ecological tool in schools, the effectiveness in students' learning has been tested with a written questionnaire. The questionnaires were given before and after the software's implementation, so as to compare and evaluate the educational capability of the tool. Furthermore, this (ecological) software was examined as an additional educational material, which supports the students' active involvement in teaching and learning, and the development of students' awareness and consciousness for significant environmental problems.

The research illustrates that the students are sensitized in matters concerning the protection of forestal ecosystems, although their knowledge was not systematized. The students are aware of their responsibility for the environmental problems; therefore they are willing to acquire more knowledge about the environment and the potentiality of its protection. It is indicative that the majority would participate delightedly in relative activities (for instance, reforestation).

However the use of new technologies in the process should not be underestimated; the students had a very positive reaction to their use during environmental courses.

To conclude, some weak points are detected the assessment of the software in the interactiveness.

Keywords: software, educational evaluation, forest ecosystem

1. Introduction

The Environmental Education (E.E.) Program is oriented towards on environmental issues. The use of New Technologies in the the E.E. Program may be unsuitable at the beginning, but the innovative approach is a part of philosophy and practice of E.E. At the International Meeting in Tbilisi (1997), the partners mentioned the environmental parameters and the technological environment, to the Media participation and to the information networks (Flogaiti, 1993).

Apart from their contribution to cognition, the use of New Technologies in Environmental Education, provides possibilities of communication, student's activation and creativity, as well as cross thematic cooperation.

Availability readjusts aims and educational methods, while lesson's content is being structured proportionately the lesson's context in the base of a balanced vertical as well as horizontal distribution of learned content (Alahiotis, 2003).

According to Grasso (2002), while some disciplines have been enriched with ICT (Information and Communication Technologies) applications, E.E. continues to be a neglected field, not having been supported as it should by ICT.

The E.E program uses the following applications of New Technologies, which are: 1) multimedia and hypermedia, 2) Geographic Informational Systems (GIS), 3) the Internet, 4) Virtual Reality and 5) simulation models.

During the last decade, in Greece a series of ICT has been focused on Studies Program, and it has helped in the creation of new curricula. Until now, few educational software programs that cover the needs of tutorial objects for all the educational degrees, have been included in different disciplines' subject matters (Georgiadou & Spurellis, 2002).

According to Heimlich and Daudi (2000), teachers must choose an educational software that accommodates student's abilities and traits. (Markopoulos, 2002).

The evaluation of this software with regard to its effectiveness in teaching and learning should be based on some criteria, which, according to Rapti and Rapti (2006), may be divided into two groups: 1) General criteria of educational content, namely how educators evaluate every method and material used in the classroom to attain the desirable teaching aims and objectives, and 2) specific criteria, including technological characteristics that are related to the computer and its use as an educational tool (e.g. the surfing capability).

Against this background the specific research questions are as follows:

1. The evaluation of the tool's educational ability and its effectiveness in teaching and learning.

2. Students' awareness and knowledge of forestal ecosystems, their protection and climate change.

2. Methodology

2.1 General remarks

Reduction in biodiversity has been established as a global environmental issue mainly over the last 10 years. There has been disagreement amongst experts whether it is a natural phenomenon or strongly influenced by human activities. However, maintaining biodiversity has been identified as one of the major pathways to sustainability. In this context, the study of biodiversity as a function of the variety of living things should be a component in the students' school education at various stages between 5 and 18 years of age (Gayford, 2000). To date, much of the biodiversity education has been materialized through the science curriculum, neglecting parameters relating to economic, political, cultural, ethical and other considerations of the topic.

It is only recently that a holistic approach to biodiversity has penetrated school education to a certain degree. In that respect, the use of ICT has proven to be instrumental. A software program called GREFOS marked out an innovation educational method. It was specifically created to offer information on the structure and the function of forest ecosystems, and the impact of the climate change on them.

The software is based on the construction of a database that includes ecological characteristics of forest species, under the form of a webpage, with taxonomical and functional information, as well as photographs from those species. The webpage has an e-book form, and it is included in an existing ecological tool.

2.2 Participants

In Greece, two optional courses concerning the environment, have been included in the curriculum for the Upper Secondary School: 1) Natural Resources Management and 2) Principles of Environmental Science. These courses address, among others, the structure and function of ecosystems, their maintenance and their stewardship.

The research was conducted in four Upper Secondary Schools from the greater area of Athens, Attica. The focus group consisted of 180 students, whose age ranged between 16 and 17 years old, without

limiting the focus group to those that had opted for either of those courses. As regards the gender, 101 of those were girls whereas 79 were boys. The objective of the research was to assess the effectiveness of the GREFOS software, as a supplementary tool in teaching and learning and the link with the existing environmental education.

The research was released to two groups as follows: Half of the sample (90 students) was called to respond to the questionnaire after having used the GREFOS software whereas the other half (90 students) had to respond without its use and only on the basis of a traditional educational method (powerpoint presentation and discussion). The former group was further called to respond to a second questionnaire for its evaluation (evaluation questionnaire).

2.3 Research tool

Three tools for the research were used:
1) The questionnaire:
2) The software
3) The statistical pack of SPSS.

2.3.1 The questionnaire

The questionnaire contained 15 (open-ended and/or closed) questions, divided in three categories: a) knowledge b) sentimental behaviour and attitude c) skill and ability.

Students were initially required to provide personal data regarding their background, such as sex and their parents' profession and level of education, followed by questions as to whether they had ever participated in an E.E program and whether they had selected either of the optional environmental courses of the curriculum, *i.e.* "Principles of Environmental Science" or "Natural Resources Management".

The first set of questions tested the students' knowledge about forestal ecosystems, for example: "With which climatic elements do you characterize the local climate of a region?" (open-ended question).

The second set of questions tested the students' sentimental behaviour and attitude of forest preservation and protection, containing questions such as: "How important do you believe maintenance and protection of forestal ecosystems are? Justify your answer" (open-ended and closed question).

The third set consisted of questions that explored the students' skills and ability towards the use of New Technologies in teaching and learning of environmental issues, along the following lines: "Would you be in favor of a more systematic use of the New Technologies in the environmental curriculum according to important environmental issues?"

The evaluation questionnaire contained questions that addressed the usefulness of the GREFOS software, such as the interest of the content and the sufficiency of information. These questions aimed to define the appraisal criteria for the planning and the effectiveness of educational software programs.

2.3.2 Software characteristics

The core of the educational software is based upon an existing scientific tool named GREFOS (Fyllas *et al.,* 2007). GREFOS is an ecosystem model, belonging to the group of individual-based forest-gap-dynamics simulators, which accounts for the full life cycle of a tree in a stand. Data regarding the size, age and competitive ability of each individual is recorded at an annual time step. The original model has been successfully applied to a wide range of forest types across Greece, with varying species pool (i.e. available species at the local level) and bioclimatic conditions (from dry Mediterranean forests to humid Temperate forests). Furthermore, GREFOS has been used to explore the potential impacts of climate change upon the dynamics of mountainous forests in Greece.

A simplified version of GREFOS has been embedded in the educational software. In its current form, each individual is established in a grid cell of 1x1 m^2. The concept of gap dynamics is applied to the stand level, while arbitrary defined cyclic neighbourhoods are considered. In these neighbourhoods trees are

competing for resources other than light, such as water and nutrients, and their competitive strength is related to their size. An emphasis has been given to simplified used interface, in which the basic steps for one to achieve a simulation are presented in the user's guide as well as though hints during the simulation time.

The above are visualized in a square grid, where the size and growth of each individual illustrated during every time step. The idea of gap dynamics where a dominant tree regulates the basic growth resources in a specific area is well presented, as around a big individual most neighbours are suppressed. When this tree dies a regenerative and growth pulse is observed and suppressed individuals are now competing to achieve dominance.

Scenarios of climate change are included in the software's code. These scenarios follow the IPCC's emissions storylines (A1, A2, B1 and B2) and are taken from Hadleys CM3 global circulation model for the region of Greece. Projected monthly shifts in temperature and precipitation drive the local climatic profile by adding this trend to the currently recorded long term climatology.

The results of each simulation are saved in an excel file, in which the user can proceed with additional statistical analyses and graphic representations of forest dynamics.

Fig.1 Students choose temperature and precipitation

Fig. 2 Students choose species (of trees)

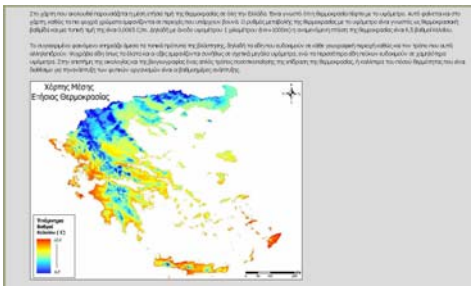

Fig.3 Students get information's about Greek climate

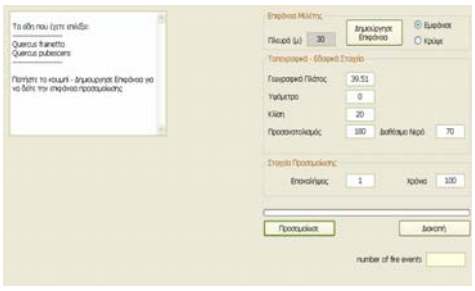

Fig. 4 Students simulate

2.3.3 The statistical pack of SPSS

Once the students filled in the questionnaires, the responses were classified in two categories according to the statistical analysis. The data were processed with the statistical pack of SPSS 15.0.

To start with, different correlations were identified on the basis of a set of two variables, the most important of which was the one between the students that had used the software before filling in the questionnaire and those that had not. The next step was to identify the frequency rate for all the variables following the use of descriptive statistics. For this purpose, a cross tabulation was employed to identify the level of the statistical importance.

3. Results

According to the results, 39,4% of the target group participated in a E.E. program. However, the participation of the target group in the optional environmental courses was relatively small; only 8,9% of the students had selected the course of "Natural Resources Management" and only 18,3% had selected the course of "Principles of Environmental Science". Consequently, there are no noticeable differences between the responses of the students that had chosen either of the two optional environmental courses and those of the students that had not done so with respect to their awareness or knowledge of forests.

As far as the first set of questions is concerned ('knowledge questions), 56,7% of the students consider that the increase of temperature (climatic change) would significantly influence the interactions of species (trees). In the question "how would you define the climate", certain students' misconceptions were diagnosed; 51,1% gave erroneous answers and only 2,2%, gave correct ones. A difficulty of expression emerged from the answers, as well as an insufficiency of comprehension and knowledge with respect to natural phenomena.

With regard to certain questions that concerned more specialised topics, it seemed that the students had already predetermined responses. For example, in the question, "which do you believe that is the most basic parameter of trees competition, based on their biological requirements?", most students answered 'water' (see *Table 1).* However, both the use of the GREFOS software and the traditional educational method revealed that the main factor is the sunlight.

Finally, the students that used the software participated more in open-ended questions (see *Table 2).*

Table 1. Identification of the most basic parameters of the trees competitiveness, based on their biological requirements

Closed type Answers	**Number of responses**	**Percentage % of responses**
Availability of solar radiation	65	36,1
Availability/Absence of water resources	111	61,7
Other answers	1	0,6
Missing answers	3	1,7
Total	180	100

Table 2. Students that used and didn't use the software, responded in the question: "with which climatic elements is the local climate of a region characterized?''

Educational tools	**Correct**	**Partly correct**	**Wrong**	**Total responses**	**Missing Answers**	**Total number of participants**
GREFOS software	2	49	21	72	18	90
Traditional educational method	4	38	22	64	26	90
Total	6	87	43	136	44	180

These were examples of questions with which student's knowledge was examined after they had either experimented with the software or attended the traditional educational method.

As far as the second set of questions is concerned (sentimental behaviour and attitude), the following remarks are relevant. The large majority of the students, i.e. 77,8%, do consider the maintenance and the protection of forestal ecosystem very important, however, they were unable to properly justify why. Less than half failed to provide a justification for the importance they attach to the forest maintenance and protection, i.e. 41,1%. One third of the target group, i.e. 32,2%, explain the importance of forest protection from an anthropocentric approach, namely that the existence of trees supports human life. In that respect, these students argue that trees provide the necessary oxygen for the development of human life. Other students consider the maintenance of the forest ecosystem significant to the ecological concatenation (an ecocentric approach), as it provides the best function of all ecosystems. Finally, one in ten students are of the opinion that the existence of all beings (humans, animals and plants) is very important (biocentric approach), (see *Table 3).*

Table 3. The second set of questions tested the students' sentimental behaviour and attitude of forest preservation and protection, containing questions such as: ''If you believe that the maintenance and the protection of forest is very important, explain your answer.''

Approaches	**Responses**	**Percentage % Responses**
Biocentric	19	10,6
Anthropocentric	58	32,2
Ecocentric	29	16,1
Missing answers	74	41,1
Total	180	100

In the question "what would you propose to people to do so as to improve the conditions of their societies and forests, to prevent the continuation of climatic change", half of the students, i.e. 50,6%, proposed solutions involving themselves, whereas 17,6% proposed solutions assigning the responsibilities in others.

The responses to the third set of questions concerning the use of New Technologies in the teaching and learning process on environmental issues revealed the positive attitude of the students; 90,6% of the students are in favor of a more systematic use of the New Technologies in the environmental curriculum according to important environmental issues (see *Table 4)*.

Table 4. The responses to the third set of questions concerning the use of New Technologies in the teaching and learning process on environmental issues, for example in a question such as: "Would you be in favor of a more systematic use of the New Technologies in the environmental curriculum according to important environmental issues?"

Answers' Type	**Responses**	**Percentage % responses**
Yes	163	90,6
No	12	6,7
Missing answers	5	2,8
Total	180	100

According to the statistical analysis, the use of the GREFOS software did not provide a statistically important added value as an additional educational material in teaching and learning compared to the

traditional educational method, as far as information is concerned. This observation nevertheless must take into account the fact that its use was limited in time (only one session for 45 minutes).

On the other hand, the software supported a more active participation of the students, not only during discussions but also in filling in open questions. Indeed, the responses of the students that used the software were more complete compared to those of the students that followed the traditional educational method.

The comments of the students in the evaluation questionnaire can be summarized as follows: 1) the software is functional, 2) preference for visual input (more pictures), 3) preference for sound and movement input, 4) new information (for example on the migration of trees due to the climate change) and 5) preference for simulation (such as depiction - representation, of all the issues that discussed in the lecture).

Finally, almost half of the students that worked with the software, i.e. 43,9 %, consider that the software does add more dimensions to the educational process, in particular:

1) Promotion of teamwork (or cooperative learning);
2) Interactive elements;
3) Promote active learning.

4.Conclusion and Discussion

This study confirms that students attach great significance to the maintenance and the protection of forestal ecosystem and are aware of their responsibility for environmental problems. Therefore, they are eager to participate in this process. However, their knowledge is not organised. Some students' responses also demonstrated their scientific illiteracy, as Mihas (2003) has already noted.

A daily interactive tool that is based among others on software applications with respect to environmental courses could ensure that important principles of environmental science are understood. To do so, students need to acquire more information about nature and processes. More particularly, students need to:

1) know how to identify plants (and animals) in the local environment;
2) have the knowledge to identify the main factors affecting plant (and animal) growth;
3) become familiar with the concept of interaction between flora, fauna and the environment and its impact on the quality of human life;
4) explain how the quality of natural environment contributes to the growth of specific plants (and animals) in their region;
5) know how to describe the reproductive system of the plants; and,
6) know how to classify plants according to certain characteristics.

In this context, the cross-thematic educational framework in combination with environmental education and New Technologies need to amplify students' ability to:

1) think critically;
2) to exploit knowledge and adopt holistic values;
3) to work in groups and learn by peers (cooperative learning); and,
4) to develop communicative skills (speaking, listening, reading, writing, arguing, etc.) (pi-schools, 2003).

The software evaluation has also revealed certain weaknesses in interaction. The role of teachers could prove instrumental in that respect. They need to be informed about new technologies on environmental issues, and choose the appropriate technological tools.

Furthermore, the students claimed that the introduction and use of New Technologies in educational setting should not just serve the purpose of technological modernization; they should rather meet certain educational criteria, ensuring the promotion of humanistic education.

The results of the present research demonstrate that E.E. is not yet fully developed in Greece. Although there have been certain positive steps in the recent years, such as (a) greater emphasis on the review of the curricula and their cross-thematic orientation with respect to environmental objectives (b) the recognition of the social character of the E.E. (c) a greater application of E.E. programs taking into account

sustainable development, and (d) the worldwide confirmation for the need to achieve E.E. due to the ecological crisis, the role of E.E. has not yet been properly defined in educational policy and practice.

Perhaps the solution lies in establishing a 'bridge' between the educational knowledge with the daily life experience, since the so-called 'life skills' (communication and social skills, cooperation, development of analytical skills, etc.) do not fall within the educational goals set out in practice in the curricula. The New Technologies could provide this 'bridge' provided that certain conditions are met.

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